SPECIAL FEATURE
SINGAPORE'S PROGRESS TOWARDS MEASLES ELIMINATION

In the 1960s and 1970s, measles epidemics occurred in Singapore every one to three years and most children developed measles after one year of age. Measles vaccination using the monovalent vaccine was first introduced to the National Childhood Immunisation Programme (NCIP) in October 1976 and administered to pre-school children at 12–24 months of age. The initial vaccination acceptance rate was poor as there were cultural beliefs that measles is an innocuous and inevitable childhood infection. To correct this belief and promote the benefits of vaccination, extensive health education programmes were conducted in Singapore between 1977 and 1979. Despite efforts in health education and routine checks of measles vaccination certificates for pre-schools and primary schools, vaccination coverage rate remained low[1].

In October 1980, measles became a notifiable disease under the Infectious Diseases Act (IDA). Cyclical epidemics continued to occur and the highest incidence was recorded in 1984 involving 2,417 cases (including seven deaths). Measles vaccination was made mandatory by law in August 1985 for all children aged 12-24 months with an aim to interrupt measles transmission by achieving vaccination coverage of at least 95% for each birth cohort by the age of two years[2].

The monovalent vaccine was substituted by the trivalent measles, mumps and rubella (MMR) vaccine in January 1990. Following a sharp rise in measles incidence in 1997, a 'catch-up' vaccination campaign was implemented from July to November 1997, targeting children aged 12-18 years regardless of their measles vaccination status or past history of measles infection. Subsequently, a second dose of MMR vaccine was introduced into the NCIP in January 1998 for primary school children aged 11-12 years.

The second dose of MMR vaccine was brought forward from 11-12 years to 6-7 years in 2008. In 2011, another change was made to the schedule, bringing the first dose to 12 months and the second dose to 15-18 months. Changes to the measles vaccination schedule over the years are summarised in Table 1.

Table 1
Changes to measles vaccination schedule, 1976 – 2011

Year	Changes made	Schedule
1976	Introduction of monovalent measles vaccine	Dose 1: 12–24 months
1990	Monovalent measles vaccine replaced with MMR vaccine	Dose 1: 12–24 months
1998	Introduction of second dose of MMR vaccine	Dose 1: 12–24 months Dose 2: 11–12 years
2008	Change in the timing of second dose of MMR vaccine	Dose 1: 12–24 months Dose 2: 6–7 years
2011 (Dec)	Changes in timing of first and second doses of MMR vaccine	Dose 1: 12 months Dose 2: 15–18 months

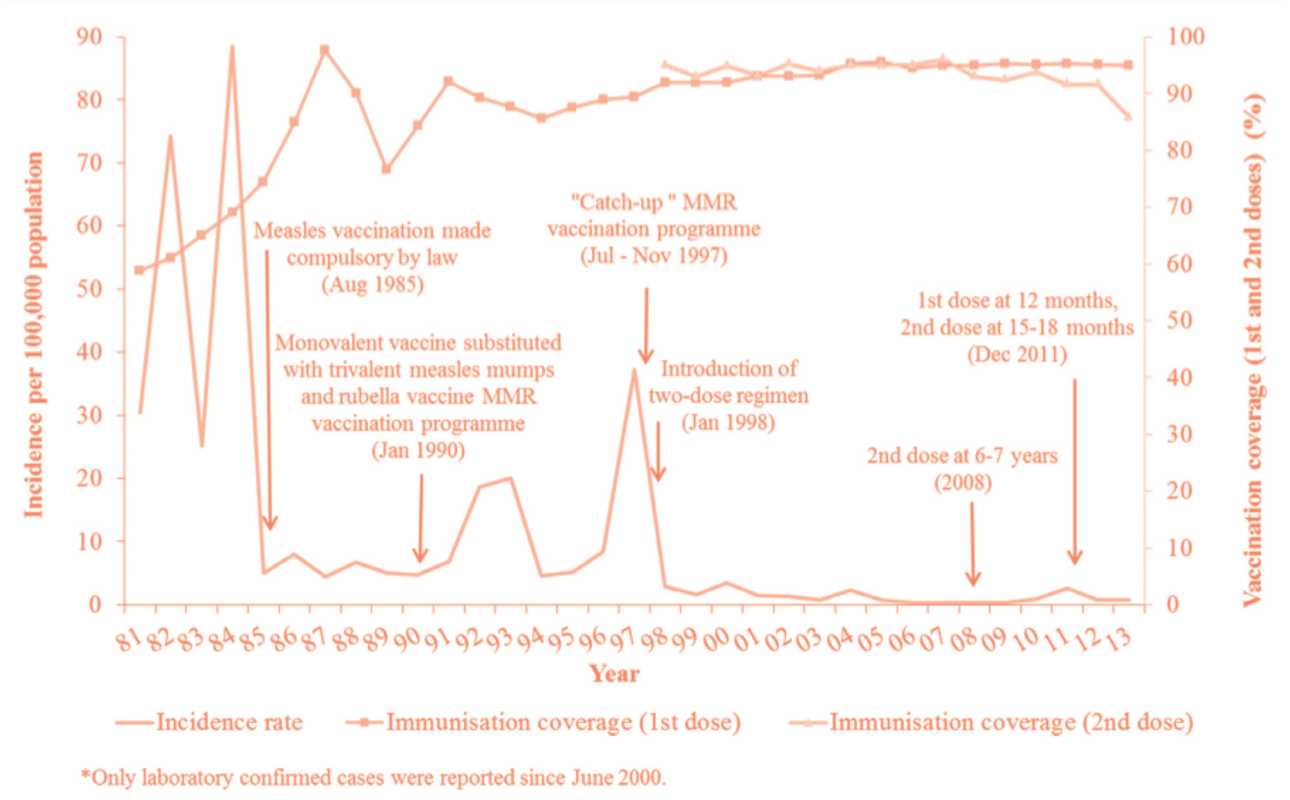
Epidemiology of measles since the introduction of vaccination

Between 1976 and 1985, cyclical epidemics continued to occur and the highest incidence of measles cases was recorded in 1984 (88.5 per 100,000 population). Since the implementation of compulsory measles vaccination in 1985, the reported measles incidence remained low until surges in measles incidence were observed in 1992, 1993, and 1997 (18.7 - 37.2 per 100,000 population)[3]. Following a 'catch-up' vaccination campaign in 1997 targeting children aged 12 – 18 years and the introduction of two-dose MMR vaccination schedule in 1998, the measles incidence declined to 2.9 per 100,000 population in 1998 and fluctuated between 0.3 and 3.5 per 100,000 population for the next decade. The vaccination coverage for children aged 2 years old steadily increased from 92.0% in 1998 to 95.3% in 2004 and has been maintained at 95% or above thereafter.

In recent years, the reported measles incidence per 100,000 population increased from 0.3 in 2009 to 0.9 and 2.6 in 2010 and 2011, respectively. Analysis of age-specific incidence showed that the increase was highest in infants aged less than one year, followed by young children aged 1-4 years. Further breakdown of cases in the 1-4 year age group shows that two-thirds were in the 12 – 24 months age-group; majority of whom were yet to be vaccinated. To address the rising trend of measles among unvaccinated young children, the timing for both MMR doses was brought forward with effect from December 2011, with the first dose to be given at 12 months of age (from 12 – 24 months) and the second dose at 15 – 18 months of age (from 6 – 7 years). In 2012 and 2013, the measles incidence decreased to 0.7 and 0.9 per 100,000 population (Fig. 1).

Figure 1

Incidence of reported measles cases and immunisation coverage in Singapore 1981 – 2013



*Only laboratory confirmed cases were reported since June 2000.

Characteristics of confirmed measles cases: 2009 – 2013

A total of 262 laboratory confirmed cases of measles were reported between 2009 and 2013. The highest incidence rate was observed in infants under one year of age, followed by young children aged one to four years (Table 2 and 3). Among the three major ethnic groups, Malays had the highest incidence rate, followed by Chinese and Indian (Table 4 and 5).

Table 2
Age distribution of reported measles cases, 2009 – 2013

Age group (years)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)
< 1	1 (12.5)	7 (15.6)	29 (21.6)	3 (8.1)	16 (42.2)
1 – 4	4 (50.0)	18 (40.0)	60 (44.8)	9 (24.3)	12 (31.6)
5 – 9	0	3 (6.7)	7 (5.2)	3 (8.1)	0
10 – 14	0	0	1 (0.7)	1 (2.7)	1 (2.6)
15 – 24	0	6 (13.3)	6 (4.5)	3 (8.1)	1 (2.6)
25 – 34	2 (25.0)	7 (15.6)	20 (14.9)	11 (29.7)	4 (10.5)
35 – 44	1 (12.5)	4 (8.8)	11 (8.3)	6 (16.3)	4(10.5)
45 – 54	0	0	0	0	0
55+	0	0	0	1 (2.7)	0
Total	**8 (100)**	**45 (100)**	**134 (100)**	**37 (100)**	**38 (100)**

Table 3
Age-specific incidence per 100,000 population of reported measles cases, 2009 – 2013

Age group (years)	2009	2010	2011	2012	2013
< 1	5.2	38.2	79.9	7.6	39.8
1 – 4	2.2	10.0	32.9	4.9	6.5
5 – 9	0	1.3	3	1.3	0
10 – 14	0	0	0.4	0.4	0.4
15 – 24	0	0.8	0.8	0.4	0.1
25 – 34	0.2	0.6	1.7	0.9	0.3
35 – 44	0.1	0.4	1.2	0.6	0.4
45 – 54	0	0	0	0	0
55+	0	0	0	0.1	0
Total	**0.2**	**0.9**	**2.6**	**0.7**	**0.7**

Table 4
Ethnic distribution of reported measles cases, 2009 – 2013

	2009(%)	2010(%)	2011(%)	2012(%)	2013(%)
Singapore Resident					
Chinese	6 (75.0)	21 (46.7)	53 (39.6)	15 (40.6)	18 (47.4)
Malay	2 (25.0)	6 (13.3)	32 (23.%)	7 (18.9)	5 (13.2)
Indian	0	5 (11.1)	13 (9.7)	0	2 (5.3)
Others	0	4 (8.9)	11 (8.2)	3 (8.1)	4 (10.4)
Foreigner	0	9 (20.0)	25 (18.6)	12 (32.4)	9 (23.7)
Total	**8 (100)**	**45 (100)**	**134 (100)**	**37 (100)**	**38 (100)**

Table 5
Ethnic-specific incidence per 100,000 population of reported measles cases, 2009 – 2013

	2009(%)	2010(%)	2011(%)	2012(%)	2013(%)
Singapore Resident					
Chinese	0.2	0.8	1.9	0.5	0.6
Malay	0.4	1.2	6.3	1.4	1
Indian	0	1.4	3.7	0	0.6
Others	0	3.2	8.8	2.4	3.2
Foreigner	0	0.7	1.8	0.8	0.6
Total	0.3	1.0	2.9	0.7	0.9

WHO classification of measles cases

A total of 132 laboratory confirmed measles cases were reported to WHO Western Pacific Regional Office (WPRO) from January to November 2014. During this period, 86% of the cases were sporadic and the rest were involved in small clusters.

The source of infection and the method of confirmation based on WHO classification are shown in Table 6. Out of 132 measles cases, 95 were classified as locally acquired and 37 were imported. The majority of imported cases originated from the Philippines, followed by Indonesia (Table 7).

From January to November 2014, there were eight small clusters involving two to four cases (Table 8). The largest cluster involved four students of a Singapore-based foreign education institution. The onset of rashes occurred between 1 and 20 April 2014, none of the cases were known to each other. Three cases were serologically confirmed for measles IgM while the fourth case was negative. One case was identified to have H1 genotype.

Among the remaining seven clusters; four were due to B3 genotype, one was due to H1 genotype, another was due to D9 genotype, and the last cluster was undetermined.

Table 6
WHO classification of measles cases, January – November 2014

Source#	Confirmed measles cases			
	Laboratory confirmed		Epidemiological Linkage	Total
	Respiratory specimen	Blood specimen		
Endemic	20 (2*)	13	0	31
Unknown	41 (7*)	30	0	64
Imported	22 (1*)	16	0	37
Imported-Related	0	0	0	0
Total	**83 (10*)**	**59**	**0**	**132**

#Source – whether the source of virus was imported, import-related, endemic or unknown, as extracted from description provided by WHO in the WHO monthly summary excel spreadsheet.

Imported: A case exposed outside the region or country during the 7-21 days prior onset to rash and supported by epidemiological or virological evidence, or both.

Import-related: A locally acquired infection occurring as part of a chain of transmission originating from an imported case as supported by epidemiological or virological evidence, or both.

Endemic: Laboratory or epidemiologically-linked confirmed cases of measles resulting from endemic transmission of measles virus.

Unknown: A confirmed case for which an epidemiologically or virological link to importation or to endemic transmission cannot be established after a thorough investigation.

* Persons who had both respiratory and blood samples collected

Table 7
Distribution of measles cases by genotype, January - November 2014

Genotypes	Classification			
	Local	Imported	Total	Country of importation (No. of persons)
B3	18	14	32	Philippines (14)
D4	0	0	0	
D8	14	1	15	Indonesia (1)
D9	17	3	20	Philippines (1) Indonesia (1) Malaysia (1)
G3	1	1	2	Indonesia(1)
H1	5	0	5	
Genotyping not performed	40	18	58	Philippines (10) Indonesia (5) Australia (1) China(1) India(1)
Total	**95**	**37**	**132**	

Table 8
Measles clusters in Singapore, January – November 2014

Size of clusters (based on number of cases)		Total no. of clusters	No. of cases in clusters (%)	No. of sporadic cases (%)	Total no. of cases (%)
2	3 – 5				
7	1	8	18 (13.6)	114 (86.4)	132 (100)

Epidemiological and laboratory surveillance systems for measles
Quality of epidemiological surveillance system for measles

The Communicable Diseases Division, Ministry of Health (MOH) is responsible for the surveillance and investigation of measles cases. A clinical measles case, based on WHO criteria, is defined as a person with fever, maculopapular rash, and one or more of the following symptoms: cough, coryza, or conjunctivitis. A laboratory confirmed case is defined as a person with positive measles IgM antibodies, or at least a four-fold rise in antibody titre, or positive virus isolation.

In recent years, antigen IF and PCR are also used to detect measles antibodies in blood samples or measles virus in respiratory samples, respectively.

In June 2012, MOH enhanced the measles surveillance system by instituting an investigation and follow up of clinically diagnosed cases, in addition to laboratory confirmed cases. Clinical cases were investigated and followed up with laboratory tests via PCR or serology if they met the clinical measles case definition. Cases were discarded if they did not meet the case definition, or if laboratory results were negative for measles.

A total of 116 cases were reported in 2013, comprising of 43 laboratory confirmed cases, seven clinically measles-compatible cases and 66 discarded cases. From January to November 2014, a total of 249 cases were reported, comprising of 132 laboratory confirmed cases, 37 clinically measles-compatible cases and 80 discarded cases. (Clinically measles compatible cases are cases which are not laboratory-confirmed but had fever, rashes and at least one of the following symptoms such as cough, coryza and conjunctivitis.)

Quality of laboratory surveillance systems for measles

The Virology Section, Department of Pathology, Singapore General Hospital (SGH), was designated a WHO National Measles Laboratory (NML) in 2001 and is a member of WHO Measles and Rubella Laboratory Network (LabNet). NML participates in WHO proficiency and confirmatory tests annually, and remains fully accredited. In 2013, 98% of specimens collected from suspected measles cases for measles IgM tests had laboratory results available within seven days after the specimens were received by the laboratory. All data from NML had been consistently reported to WPRO and MOH within the required time intervals. The NML accreditation results are summarised in Table 9.

NML performs diagnostic tests for both measles and rubella IgM upon request from attending clinicians. NML also identifies measles cases by measles antigen detection on direct patient samples using immunofluorescence assay (IFA) and by virus isolation, as ordered by clinicians for suspected cases. To enhance surveillance, virus isolation is also performed on specimens sent for measles antigen detection. Sequencing is performed on virus isolates to determine the genotype.

Table 9
Summary of NML accreditation results, January 2013 – August 2014

Year	Score of onsite review	Proficiency test score (%)		Confirmatory test score (%)		Results reported within 7 days of receipt of specimen# (%) (within 4 days w.e.f. April 2013)		Virus genotyping completed within 2 months of receipt of specimen (%)	Fully accredited (Yes / No)
		Measles IgM	Rubella IgM	Measles IgM	Rubella IgM	Measles IgM	Rubella IgM	Measles	
2013	99%	95	100	100	100	98.0	96.9	100	Yes
2014	Pending	Pending	Pending	Pending	Pending	96.9	98.3	100	Pending

With effect from April 2013, reporting of measles IgM and rubella IgM results is changed to within four days from receipt of samples.

Serological tests and results

In June 2012, measles surveillance was enhanced with serological cross-testing between measles and rubella IgM on specific patient samples requested by MOH. From June 2012 to August 2014, 1,970 samples were tested. A total of 68 samples were positive for measles IgM and 47 samples were positive for rubella IgM. A summary of specimens processed by NML is in Table 10.

Table 10
Specimens submitted to NML for measles and rubella testing, June 2012 – August 2014

Year	Total no. of patient with specimen	Total no. of specimens received	Serology (serum and blood)								Measles virus isolation	
			Measles IgM			Results ≤ 7 days#	Rubella IgM			Results ≤ 7 days#		
			No. tested (-)	No. tested (+)	No. tested equiv	%	No. tested (-)	No. tested (+)	No. tested equiv	%	No. tested	No. of isolates
Jun–Dec 2012	760	834	230	14	5	97.2	363	23	14	97.8	185	4
Jan-Dec 2013	616	667	176	16	7	98.0	266	16	10	96.9	176	5
Jan–Aug 2014	427	469	111	38	11	96.9	170	8	1	98.3	127	6

#With effect from April 2013, reporting of measles IgM and rubella IgM results is changed to within four days from receipt of samples.

Virological surveillance

As part of the enhanced measles surveillance system, a higher proportion of measles cases with positive PCR result is followed up with genotypic analysis. This will lead to a better understanding of the origin of measles cases notified in Singapore and aid in the tracing of epidemiological linkages amongst cases.

Table 11 shows the proportion of all lab-confirmed samples with genotyping. Table 12 shows the measles genotypes identified in Singapore from January 2011 to August 2014. The genotype distribution shirted from D9 genotype in 2010 – 2011, B3/D9 genotypes in 2012, G3/D9 genotypes in 2013, and to B3 genotype in 2014. The B3 genotype was first detected in 2012 and became predominant in 2014. Two imported cases from the Philippines with B3 genotype were reported in early 2014. Subsequently, locally acquired and imported cases with genotype B3 were reported until e-week 11. Three sporadic cases with genotype B3 were further reported in the year (Fig. 2). Fig. 3 – 5 show the incidence of measles for genotypes B3, D8 and D9 from January – November 2014.

Table 11
Proportion of measles cases with genotyping among lab-confirmed samples* in Singapore, January 2011 – November 2014

	Year			
	2011 (%)	**2012 (%)**	**2013 (%)**	**2014 (%) Jan – Nov**
Number of samples genotyped	46 (54.1)	6 (5w4.4)	33 (86.7)	74 (89.2)
Number of samples not genotyped	39 (45.9)	5 (45.6)	5 (13.3)	9 (10.8)
Total	**85 (100)**	**11 (100)**	**38 (100)**	**83 (100)**

*Lab-confirmed respiratory samples only

Table 12
Distribution of measles genotypes among lab-confirmed samples* identified in Singapore, January 2011 – November 2014

	Year			
Genotype	**2011 (%)**	**2012 (%)**	**2013 (%)**	**2014 (%) Jan – Nov**
B3	-	3 (50.0)	6 (18.1)	32 (38.6)
D4	1 (2.2)		-	-
D8	11 (23.9)	-	4 (12.1)	15 (18.1)
D9	33 (71.7)	3 (50.0)	9 (27.3)	20 (24.1)
G3	1 (2.2)	-	10 (30.3)	2 (2.4)
H1	-	-	3 (9.1)	5 (6.0)
Vaccine type A	-	-	1 (3.1)	-
Total	**46 (100)**	**6 (100)**	**33 (100)**	**74 (100)**

*Excluding Measles IgM positive samples from serology

Figure 2

Measles virus genotypes identified from January - November 2014

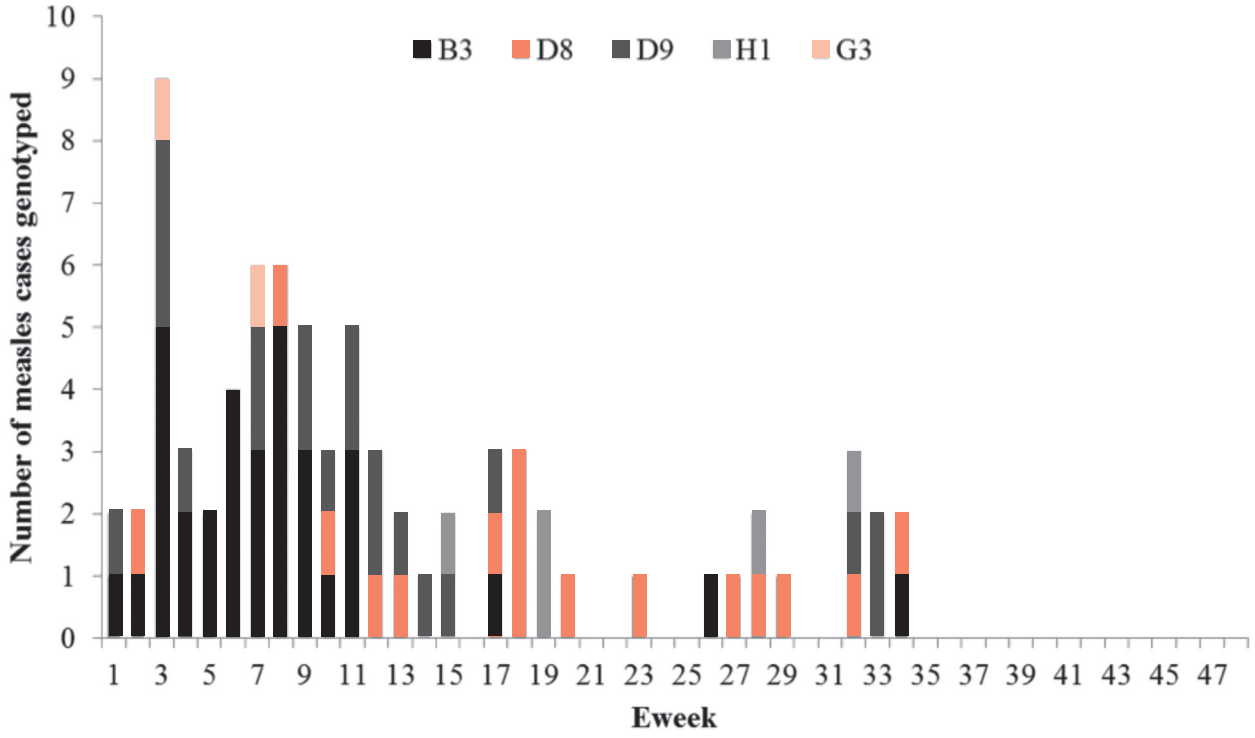


Figure 3

Incidence of measles genotype B3, January - November 2014

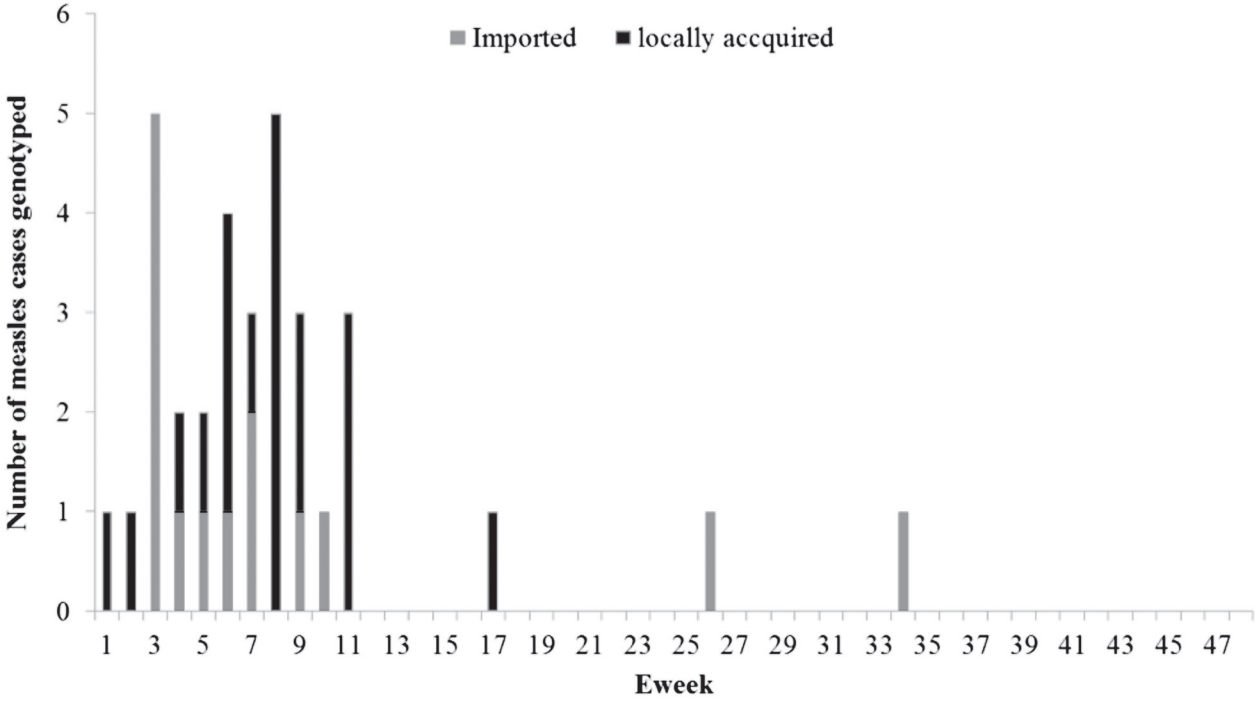


Figure 4

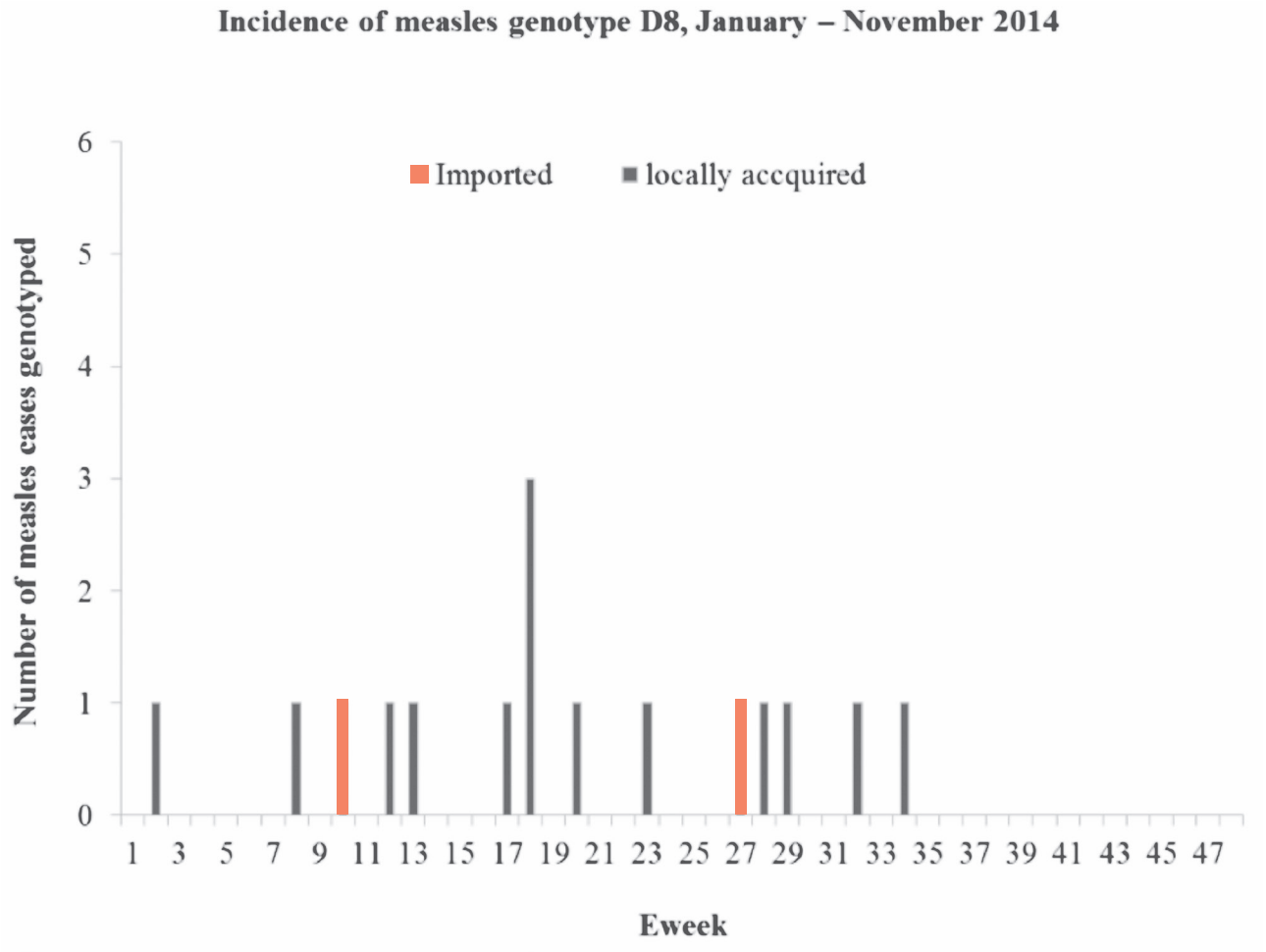
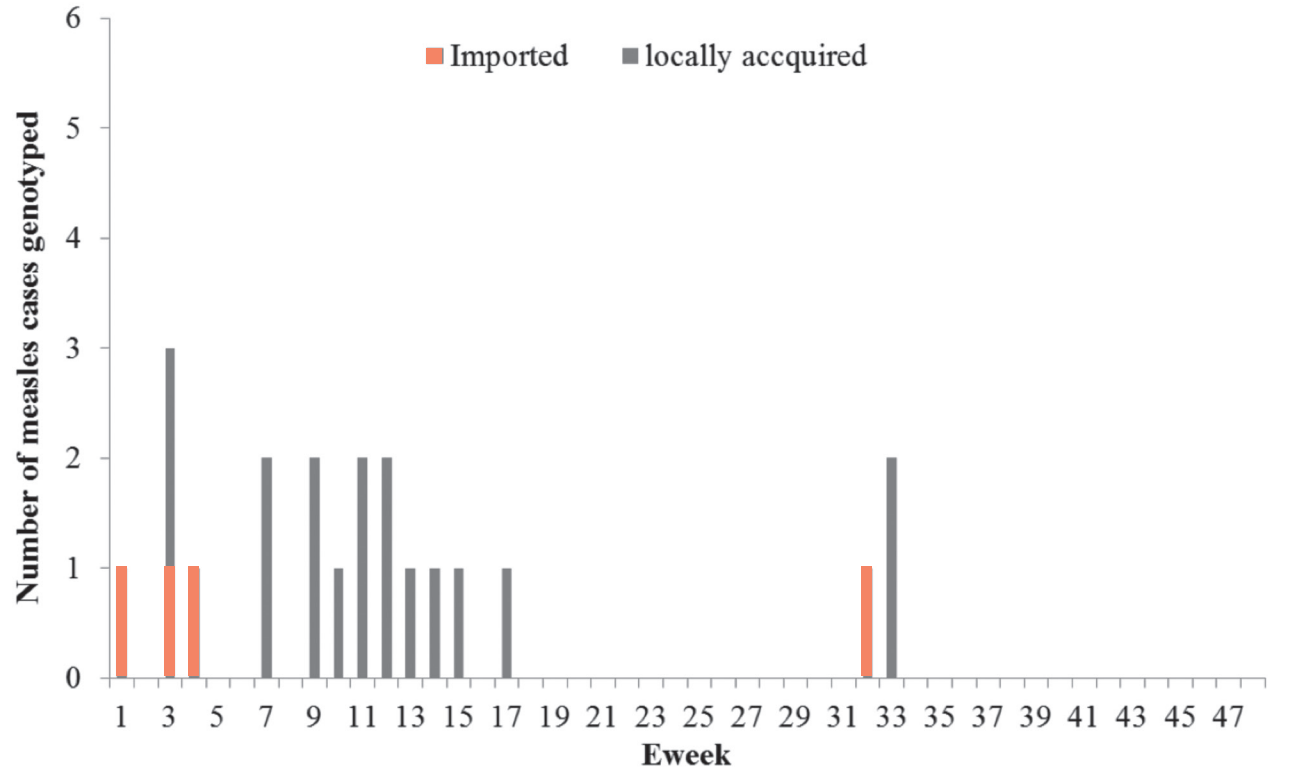


Figure 5



Immunisation Coverage

The National Immunisation Registry (NIR), Health Promotion Board (HPB), monitors and tracks the coverage of immunisations in the NCIP among resident children (Singapore citizens and permanent residents). Immunisation coverage for measles has remained consistently high, and maintained at around 95% (Table 13).

A set of indicators was developed by WHO WPRO, covering i) incidence, ii) surveillance, and iii) population immunity. Table 14 shows Singapore's current status in comparison to WHO targets.

Table 13
Measles, mumps and rubella immunisations, 2003 – 2013
Infants and pre-school children
No. completed first dose by age 2 years

Year	Number	Coverage (%)
2003	36,956	93.2
2004	36,845	95.3
2005	33,843	96.6
2006	31,638	94.5
2007	31,217	95.0
2008	30,352	94.9
2009	34,057	95.2
2010	32,165	95.1
2011	29,992	95.2
2012	28,320	95.1
2013	29,125	95.0

Table 14
Singapore's progress towards measles elimination

Indicator	WHO Targets	Current (2014)*
A. Very Low Incidence		
Confirmed measles cases (by laboratory, epidemiologic linkage or clinically)	< 1/1,000,000	29.7/1,000,000
B. High Quality Surveillance		
National reporting of non-measles suspected cases	≥ 2/100,000	1.6/100,000
Percentage of districts reporting ≥ 1/100,000 non-measles suspected cases	≥ 80%	NA
Percentage of suspected cases with adequate investigation within 48hrs of notification	≥ 80%	83.7%
Percentage of suspect cases with adequate blood specimens	≥ 80%	25.5%
Percentage of specimens with lab results ≤ 4 days after arrival to lab	≥ 80%	85.2%
Transmission chains (outbreaks) with sufficient samples for virus isolation	≥ 80%	100.0%
C. High Population Immunity		
National MCV1 and MCV2 coverage	≥ 95	≥ 95
Percentage of outbreaks or transmission foci with < 10 cases	≥ 80%	100.0%
Absence of endemic measles virus	No virus	Endemic

*Measles-Rubella Bulletin - Vol 8 Issue 11 (November 2014) http://www.wpro.who.int/immunization/documents/mrbulletinvol8issue11.pdf?ua=1

Conclusions

Singapore maintains an established system of measles notification, epidemiological surveillance and outbreak response, including the tracing of contacts if necessary. Each case is investigated thoroughly to determine any common exposures in place and time with other cases. NML remains fully accredited and plays a key role in the system. Vaccination coverage for the first dose is maintained at 95%. Despite maintaining high immunisation coverage, there are still sporadic measles cases occurring in Singapore.

Singapore met most of WHO indicators for measles elimination in 2014, except for incidence of measles cases and adequate blood specimens from clinical cases. Among the 132 laboratory-confirmed cases, 83 (63%) were respiratory specimens. As most of the cases involved infants, respiratory specimens (throat swabs) were collected for confirmation via PCR instead of blood specimens. In this context, Singapore's indicator for the percentage of suspect cases with adequate blood specimens does not truly reflect the effort made to confirm suspect cases, as PCR is the mainstay of laboratory confirmation. The majority of the specimens in 2010 and 2011 associated with endemic transmission in Singapore were D9 genotype. The dominant genotypes were B3/D9 in 2012, G3/D9 in 2013 and B3 in 2014. Other genotypes (D8, G3 and H1) were also detected. Singapore receives about 15 million international visitors annually[4]. The variation of genotypes detected is indicative of importation from other countries. The ability to collect appropriate specimens from as many of the cases as possible is an important factor in determining the source of infection. Encouraging clinicians to send specimens for laboratory confirmation of clinical cases is a challenge, as the cost of laboratory test would need to be borne by the patient.

Although Singapore has a well-established system for measles notification, there is still progress to be made towards measles elimination[5]. MOH has increased its efforts to perform genotyping for all positive respiratory samples; a 3% increase in 2014 compared to year 2013 and also to ensure harmonisation of genotyping data. Detailed epidemiological analysis is carried out for each notified measles case; all clinical cases are investigated and followed up with recruitment into the enhanced measles and rubella surveillance programme. This will aid establishing chains of transmission and source of infection with genotyping results.

References

1. Goh KT. The national childhood immunisation programme in Singapore. Singapore Med J 1985;26:225-42
2. Ong G, Heng BH, Chua LT et al. A 24-year view on the epidemiology and control of measles in Singapore, 1981-2004. Southeast Asian J Trop Med Pub Hlth 2006;37:96-101
3. Liew F, Ang LW, Cutter J et al. Evaluation on the effectiveness of the National Childhood Immunisation Programme in Singapore, 1982-2007. Ann Acad Med Singapore 2010;39:532-41
3. World Health Organisation, Western Pacific Region. Measles-rubella Bulletin, vol 8 issue 11, November 2014. http://www.wpro.who. int/immunization/documents/mrbulletinvol8issue11.pdf?ua=1
4. Singapore Tourism Board
5. Ho HJ, Low C, Ang LW et al. Progress towards measles elimination in Singapore. Vaccine 2014;32:6927-33

CLUSTER OF CLINICAL SARCOCYTOSIS CASES

Notification

The Ministry of Health (MOH) was notified by an infectious disease physician from the National University Hospital (NUH) on 25 Jul 2014 of two students suspected of having muscular sarcocystosis. They had been on a school trip to Tioman island, Malaysia, from 6 – 13 June 2014. One was hospitalised and the other was treated as an outpatient.

Epidemiological investigation

Investigations carried out revealed that these two students were among a group of 125 grade eight students and 7 staff members (n=132) who had visited the island. They were divided into three groups. Each group had a separate departure date on 6 June, 7 June or 9 June 2014. Each group stayed in the island for 5 days at either Juara Beach Resort or Riverview Resort, both located at the Juara Beach area. All three groups had identical itineraries including kayaking at Juara Beach, trekking to waterfall at Mentawak and an overnight stay at a campsite in Dungun.

A. Findings

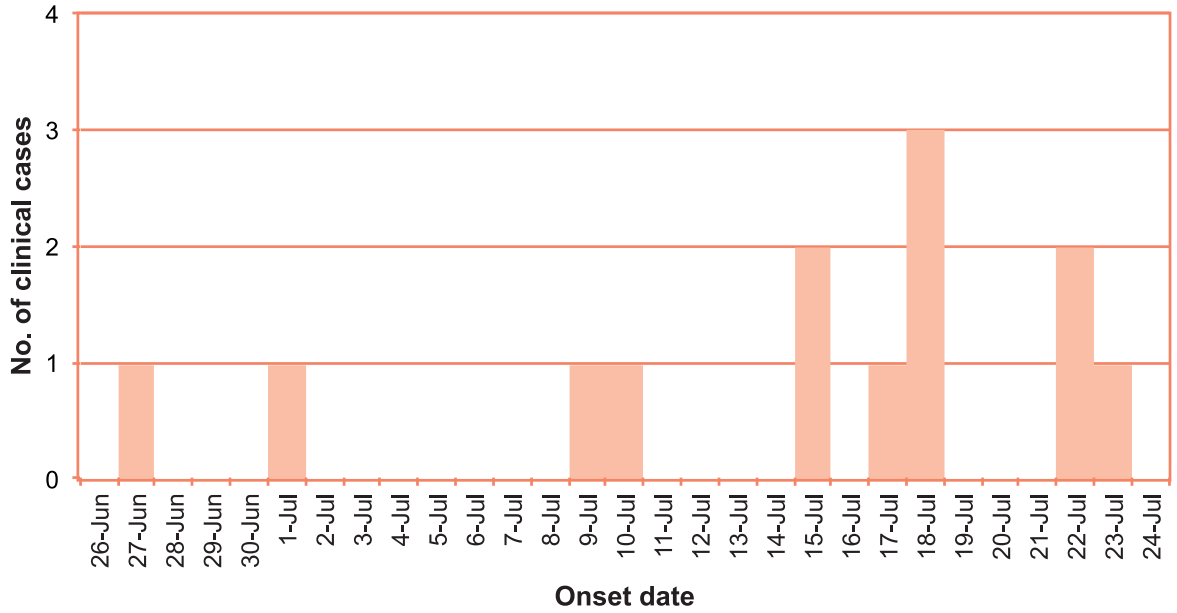
A case was defined as a previously well individual who had visited Tioman island between 6 and 13 June 2014 and subsequently developed myalgia from 27 Jun to end of July 2014. Based on this case definition, a total of 13 cases (all students aged 13 – 14 years) were identified. One staff member with fever was subsequently diagnosed to have dengue fever. The attack rate of the students was 10.4%. The onset of myalgia was between 27 June and 23 July 2014 (Fig 1) . The mean and median incubation periods were 31 days and 33 days (range 14 – 40 days), respectively.

B. Treatment

The signs and symptoms included myalgia (100%), fever (92%), nausea (54%), headache (38%), diarrhoea (31%) and abdominal pain (31%). The laboratory findings were eosinophliia in all cases and elevated creatine kinase in 3 cases. No specific tests were performed to confirm the diagnosis of sarcocystosis. Four cases (30.8%) were hospitalised. Eight cases (61.5%) sought outpatient treatment while one (7.7%) self-medicated. All had recovered.

Figure 1

Onset of myalgia of 13 students who had travelled to Tioman island from 6 – 13 June 2014



A case-control study comprising 9 cases and 25 controls was conducted to determine the possible sources of infection. . Swimming at the Mentawak waterfall, drinking chlorine-treated river water at Dungun campsite and Jetty Jump, using branches (picked from ground) to skew marshmallows and consuming it around the camp fire were not significantly associated with illness. Other risk factors such as contact with animals, drinking untreated/ unfiltered water, inadvertent ingestion of water during swimming and consumption of raw/ undercooked food items (e.g. fruits, vegetables and meats) were also found not to be statistically significant.

Discussion

This is a cluster of clinical sarcocystosis cases involving 13 students who had travelled on a school trip to Tioman island, Malaysia, between 6 and 13 June 2014. The clinical symptoms (predominantly myalgia and fever), incubation period (mean of 31 days) and laboratory findings were compatible with the clinical and epidemiological description of muscular sarcocystosis infection (e.g. incubation period of 14 – 42 days). As muscle tissue biopsies were not carried out, we were unable to confirm the causative agent.

Cases of sarcocystis association with travel to Tioman island.[1], [2] had been reported previously in 2011, 2012 and 2014. Activities such as kayaking at Juara Beach, swimming in the waterfall area at Mentawak and overnight stay at the Dungun campsite could have potentially exposed individuals to sarcocystis oocyst-contaminated water, e.g. swallowing of water while swimming and drinking of chlorine-treated river water at Dungun campsite.

We hypothesize that treated water or untreated water from the natural environment as the likely source of the infection. A study indicated that treatment with chlorine is ineffective to prevent sarcocystosis infection in contaminated water[3]. Furthermore, there is a possibility of animal reservoir of sarcocystosis which could contaminate the water within Tioman island. Besides ingestion of contaminated water, consumption of undercooked meat is another possible route of transmission. However this is unlikely as the incubation period observed in reported cases of intestinal sarcocystosis infection (incubation period of 3 - 6 hours[4]) did not fit the incubation period of our cases (4 – 6 weeks).

References:

1. Esposito DH, Freedman DO, Neumayr A, Parola P. Ongoing outbreak of an acute muscular sarcocystis-like illness among travellers returning from Tioman Island, Malaysia, 2011-2012. Euro Surveill 2012;17:pii=20310.
2. Tappe D, Stich A, Langehelnecke A et al. Suspected new wave of muscular sarcocystosis in travellers returning from Tioman Island, Malaysia, May 2014. Euro Surveill 2014;19:pii=20816.
3. J.P. Dubey, W.J. Saville, C. Sreekumar, S.K et al. Effects of high temperature and disinfectants on the viability of Sarcocystis neurona sporocysts. J. Parasitol 2002; 88:1252–4.
4. Ronald Fayer. Sarcocystis spp. in Human Infections. Clin Microbiol Rev. 2004 October; 17(4): 894–902. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC523554/